Developmental relations between ADHD symptoms and bullying perpetration and victimization in adolescence

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Abstract

It has previously been hypothesised that individuals with elevated ADHD symptoms are at greater risk of bullying perpetration and victimization. Using autoregressive latent trajectory models with structured residuals (ALT-SR) and four waves (ages 11, 13, 15 and 17) of longitudinal data from the normative z-proso study (n=1526, 52% male), we evaluated the developmental relations between ADHD and bullying using both self- and teacher-reported ADHD symptom data. Analyses suggested that ADHD symptoms primarily increase the risk of bullying perpetration, with a within-person effect of ADHD symptoms on bullying perpetration symptoms identified across ages 13 to 15 (β=.13) and ages 15 to 17 (β=.19) based on self-reported ADHD symptoms and a similar effect identified across ages 11 to 13 (β=.24) and 13 to 15 (β=.29) based on teacher-reported inattention symptoms. There were also some indications of reciprocal effects and effects involving victimization that merit further exploration in future research. Results imply that the content of bullying intervention and prevention programs should take account of ADHD symptoms in order to ensure that those with elevated symptoms can benefit as much as their typically developing peers. This will involve addressing bullying perpetration that may reflect impulsive/reactive aggression and impaired social skills rather than instrumental aggression. Further, programs should go beyond classical curriculum/classroom-based delivery to ensure that individuals with elevated ADHD symptoms can be successfully engaged.

Bullying can be defined as an intentional, frequent, and long-term antisocial behavior in which aggression is perpetrated against a weaker peer (Olweus & Limber, 2003). Children and adolescents with elevated ADHD symptoms have proposed to be at increased risk of both bullying victimization and perpetration (Fite et al., 2014).

Individuals with ADHD symptoms are liable to experience greater emotional reactivity, social skills deficits, reactive/impulsive aggression, and other disruptive behaviors which can elicit negative reactions from peers (Close et al., 2010; Stenseng, Belsky, Skalicka, & Wichstrøm, 2016; Wehmeier, Schacht, & Barkley, 2010). Difficulties in interacting effectively with peers can also place young people at greater risk of rejection by normative peers, compounding their risk of victimization (Cook, Williams, Guerra, Kim, & Sadek, 2010). Thus, young people with elevated ADHD symptoms may be seen as a both desirable and easy targets for bullying due to a combination of being easier to provoke and diminished normative peer support (Roy et al., 2015). In terms of perpetration, reactive/impulsive aggression associated with ADHD symptoms (Murray et al., 2016), when directed at less powerful peers, can be considered a form of bullying perpetration. Further, due to their greater tendency to be rejected by normative peers, young people with ADHD symptoms are more likely to affiliate with deviant peers who may encourage antisocial behaviors such as bullying (e.g., Bennett, Pitale, Vora, & Rheingold, 2004).

Though the idea has received less attention, is also possible that the links between ADHD symptoms and bullying are bidirectional. For example, victims of bullying are at increased risk of experiencing anxiety and depression (Arseneault, 2018), which involve worry and attentional biases towards negative stimuli that could compound attention problems associated with ADHD (A. L. Murray et al., 2020; Stenseng et al., 2016).

Despite the face validity of pathways linking ADHD and bullying, the evidence for their association is mixed (Bacchini, Affuso, & Trotta, 2008; Chou, Liu, Yang, Yen, & Hu, 2018; Fite, Evans, Cooley, & Rubens, 2014; Roy, Hartman, Veenstra, & Oldehinkel, 2015; Sciberras, Ukoumunne, & Efron, 2011; Unnever & Cornell, 2003; Verlinden et al., 2015; Yen et al., 2014). While several studies have found that both bullying victimization and perpetration are associated with ADHD symptoms in children and adolescents (Holmberg & Hjern, 2008; Unnever & Cornell, 2003; Verlinden et al., 2015; Yen et al., 2014), other studies have found an association with victimization only (Sciberras et al., 2011), with being a victim or bully/victim (i.e., an individual who is both the victim and perpetrator of bullying) but not a pure bully (Taylor, Saylor, Twyman, & Macias, 2010), or an association limited only to males or females (Bacchini et al., 2008). Other studies have found no association or no association after adjustment for comorbid disruptive behavior disorders (DBDs; Chou et al., 2018; Fite et al., 2014).

The inconsistency of results may partly reflect the methodological limitations of many previous studies of ADHD-bullying associations which have often used small, non-representative samples. Further, while the majority of previous studies have been cross-sectional (see, e.g., Chou et al., 2018; Roy et al., 2015; Verlinden et al., 2015 for exceptions), longitudinal studies are essential for understanding the temporal sequence of ADHD symptom/bullying development to help disentangle their various possible forms of developmental relation.

Further advancing knowledge in this area is important because the developmental links between ADHD and bullying have several potentially important implications. For example, components addressing ADHD features relevant to bullying (such as emotional reactivity, impulsive aggression, social processing difficulties) could

be important in anti-bullying interventions. At present, the most widely implemented and effective anti-bullying interventions tend to focus on creating whole-school anti-bullying cultures but with less emphasis on how to support individuals (such as those with ADHD symptoms) who may have difficulties adjusting their behavior to be in line with these cultures (Gaffney, Ttofi, & Farrington, 2019; Salmivalli & Poskiparta, 2012).

Though previous research has focused particularly on the relations between ADHD symptoms and bullying in childhood, ADHD and bullying remain significant issues in adolescence and for a proportion of young people, show a first onset during this time (Polanczyk et al., 2015; Zych et al., 2015; Zych, Farrington, Llorent, Ribeaud, & Eisner, 2020; Zych et al., 2020). Adolescence is also a time of substantial social, cognitive, and physical change where peer relationships change in their nature and significance (Rapee et al., 2019). Thus, though they may begin in childhood, the dynamics of peer problems such as bullying and their relations with issues such as ADHD may not generalise from childhood to adolescence in a straightforward manner.

Given the need for high quality longitudinal studies to illuminate the developmental dynamics of ADHD symptoms and bullying, we here analyzed the age 11, 13,15 and 17 waves of the normative z-prosos study. In order to provide evidence on whether ADHD symptoms impact bullying victimization/perpetration levels and vice versa, we fit autoregressive latent trajectory models with structured residuals (ALT-SR; Curran, Howard, Bainter, Lane, & McGinley, 2014). ALT-SRs essentially partial out effects that are time-stable but vary across individuals (which may include factors such as genetic effects, family disadvantage, or intellectual impairment that are common to both bullying and ADHD), they allow the reciprocal within-person effects of the two variables to be estimated. Thus, in contrast to models such as cross-lagged panel models which provide a difficult-to-interpret amalgam of between- and within-person effects,

ALT-SRs allow the within-person relations between ADHD and bullying to be studied (Berry & Willoughby, 2017). Given gender differences in levels of both ADHD and bullying (with males scoring higher on both Cook et al., 2010; Polanczyk, De Lima, Horta, Biederman, & Rohde, 2007), developmental trajectories for ADHD (Murray, Booth et al., 2019), and the possibility that ADHD-bullying relations differ for males and females (Chou et al., 2018) we conducted gender-adjusted and gender-stratified analyses.

Method

Participants

Participants were from the z-proso study. Z-proso is an ongoing longitudinal study of child development. The sample is normative, i.e., community-ascertained, non-clinical; however, it will include individuals who meet clinical diagnostic criteria for ADHD by virtue of the fact that ADHD is a relatively common disorder in childhood and adolescence. While the z-proso study did not involve clinical diagnostic assessments for ADHD, data provided by participants on medication use suggest that approximately 5% of the sample use medications that are commonly prescribed for ADHD, and thus likely experience clinically significant ADHD symptoms. This is approximately in line with global prevalence estimates for this age group (Polanczyk et al., 2015).

The sampling frame for the study was based on participant attendance at one of 56 schools in Zurich, Switzerland. The schools were selected based on a stratified random sampling procedure that considered school size and location. Across the 56 schools, the target sample totalled 1,675 young people of whom 1,620 have contributed data in at least one wave.

The first data collection wave occurred in 2004 when the participants were 7 years old and entering the first grade, with additional main data collections at ages 8,9,10,11,12,13,15,17 and 20. This data collection schedule was determined by several factors, including the resources available at various stages of the study. The schedule sought to strike a balance between achieving rich developmental data following the timescales over which substantive developmental change in constructs such as bullying, ADHD, aggression and other key constructs in the study occur and avoiding over-burdening participants and risking high levels of drop-out. Importantly, the entire period of mandatory schooling in Switzerland is covered by the study.

In the current study, we focused on age 13 onwards for one set of analyses (n=1,483) because age 13 is the first wave at which ADHD symptoms were measured using self-reports. That set of analyses thus concerns the n=1,483 (n=1,343-1,364 at age 13, n= 1,337-1,446 at age 15, n=1294-1304 at age 17) young people who contributed self-reported bullying and/or ADHD data in adolescence (median ages 13, 15, and 17), representing 86% of the total original target sample from baseline. We also conducted analyses using teacher-reported ADHD symptoms (available at ages 11,13, and 15), for which some additional datapoints (n=1,526 total; n=1,059-1,144 at age 11, n= 1,257-1,363 at age 13, and n=1,283-1,446 at age 15) were available. Analyses of non-response and attrition suggest that non-response and attrition was at most weakly related to factors that may bias the findings of the current study (Eisner et al., 2018). Specifically, analyses suggest that ADHD symptoms were related to drop-out (OR=1.30) but only according to teacher-reports (not self- or parent-reports) and not after correction for multiple comparisons. Other significant predictors of non-response and drop-out were having a primary caregiver who spoke certain languages other than German (the official language of the study location) as their first language, being in a

small class (usually indicative of special educational needs, including not yet being fluent in German).

The sample used in the current study was diverse in terms of socioeconomic and ethnic background. The mean International Socio-Economic Index of Occupational Status (ISEI)score (Ganzeboom et al., 1992) was 44.82 (approximately corresponding to the occupational prestige of a book-keeping clerk; SD= 17.75). Only 48% of the sample were born to a primary caregiver who was originally from Switzerland. Other common primary caregiver nations of origin included Germany (4%), Italy (4%), Serbia and Montenegro (7%), Yugoslavia (3%), and Turkey (3%). Approximately equal numbers of males and females provided data used in the current study (52% males).

Further details of z-proso, can be found via the study website: https://www.jacobscenter.uzh.ch/en/research/zproso/aboutus.html and in prior publications (Eisner et al., 2018).

Measures

ADHD

Both self-reported and teacher-reported ADHD symptoms were measured in the current study using the appropriate informant version of the *Social Behavior Questionnaire (SBQ;* Tremblay et al., 1991). Both teachers and the adolescents themselves were used as informants because previous research suggests that different informants can capture different aspects of child and adolescent behavior (De Los Reyes, 2013). The SBQ was selected for this study because of the availability of different informant versions and because it provides a brief but reliable omnibus assessment of a range of emotional and behavioral issues.

In the self-reported measure, two items captured attention problems, referring to: difficulty concentrating and experiencing inattention; and two captured hyperactivity/impulsivity, referring to: restlessness/hyperactivity and being fidgety. In the teacher-reported measure, four items captured attention problems, referring to: having difficulty settling to anything for long, being distractible, difficulty concentration, and inattention; and four items captured hyperactivity/impulsivity problems, referring to: impulsivity, difficulty waiting on one's turn, restlessness/hyperactivity, and being fidgety. Item wordings for both measures are provided in Supplementary Materials. Global ADHD scores were derived from the self-report measures due to an insufficient number of items to derive separate reliable inattention and hyperactivity/impulsivity scores; however, separate inattention and hyperactivity/impulsivity scores were possible for the teacher reports. Responses were recorded on a five-point Likert scale from 1= *never* to 5= *very often*. Item Ns ranged from 1,295 (age 17) to 1,446 (age 15) for the self-reported data and from 1,060 (age 11) to 1,256 (age 17) to for the teacher-reported data. Previous analyses have supported the validity and reliability of the items, as well as their developmental invariance across adolescence in the current sample (A. L. Murray, Eisner, et al., 2017; A. L. Murray, Obsuth, et al., 2017). Omega internal consistency values for the self-reported ADHD scale in the current study were: .70 for age 13, .76 for age 15, and .78 for age 17, supporting the reliability of the scale. Omega for the teacher-reported inattention was .96 for age 11, .95 for age 13 and .95 for age 15. Omega for teacher-reported hyperactivity/impulsivity was .92 for age 11, .93 for age 13, and .92 for age 15.

Bullying

Bullying victimization and perpetration were measured in parallel form using the *Zurich Brief Bullying Scales* (ZBBS; Murray et al., 2019). The ZBBS covers four major

manifestations of bullying: physical aggression, verbal aggression, social aggression, and property destruction. A self-reported perspective was prioritised because it can be difficult for informants such as teachers to gauge whether a given behavior was intentionally harmful and because much bullying behavior is covert (Furlong, Sharkey, Felix, Tanigawa, & Green, 2010).

Items are measured on a 6-point scale with response options:1 = never, 2 = 1 to 2-times, 3 = 3 to 10-times, 4 = about once a month, 5 = about once a week, and 6 = (almost) every day. Item Ns ranged from 1,299 (age 17) to 1,444 (age 15). Previous analyses have supported the validity of the measure in the current sample (A. Murray et al., 2019). Omega values for the scale in the current study were: .77 for age 13, .71 for age 15, and .71 for age 17 victimization and .78 for age 13, .76 for age 15, and .71 for age 17 perpetration, supporting its reliability in the sample.

Ethical Considerations

Ethical approval was obtained from the Ethics Committee from the Faculty of Arts and Social Sciences of the University of Zurich. Active informed consent was obtained from parents up until age 12, after which active informed consent was obtained from the participants directly; however, parents could still choose to opt their child out until the age of 18.

Data Analysis

Autoregressive latent trajectory model with structured residuals (ALT-SR)

In order to explore whether ADHD predicts within-person changes in bullying victimization and perpetration, and/or vice versa, we fit a series of ALT-SR models (Curran et al., 2014). The ALT-SR fits a cross-lagged structure to the residuals of a parallel process growth curve model with random intercepts (but no random effect for

slopes), with intercept factors covarying across variables. In doing so, the model disaggregates between- and within-person relations between constructs. The cross-lagged parameters can then be used to assess directional relations between ADHD and bullying over development.

Time intervals were fixed proportional to the difference between the median participant age at each time point. Separate models were fit to examine ADHD-victimization and ADHD-perpetration relations and for teacher- and self-reports. Given that there are known gender differences in both ADHD symptoms and bullying, and their developmental trajectories (Murray et al., 2019; Murray, Booth, Eisner, et al., 2018), gender was adjusted for by regressing intercept factors on gender. Further, as an additional method of accounting for gender differences, models were fit separately for males and females.

We used a two-step approach to model fitting because of estimation difficulties in jointly estimating the longitudinal measurement model and the ALT-SR. Both steps utilised robust maximum likelihood estimation in *Mplus 8.4* (Muthén & Muthén, 2015). In the first step, factor scores were obtained for ADHD symptoms and bullying victimization/perpetration at each wave. For the ADHD self-reports there were too few items of each to separately obtain scores for inattention and hyperactivity/impulsivity, therefore, a global ADHD score was estimated for each wave. For ADHD teacher-reports, inattention and hyperactivity/impulsivity were estimated using separate scores. Scaling and identification in the measurement models were achieved by fixing the mean and variance of each construct at baseline (age 13 for the self-reports and age 11 for the teacher-reports) to 0 and 1 respectively and the loading and intercept of the first item for each construct fixed equal over time. Factor score determinacies for the victimization and perpetration constructs for teacher-reported inattention and

hyperactivity/impulsivity were all >.90. For ADHD they fell slightly below for the self-reports >.90 and were .87, .89 and .89 for ages 13,15 and 17 respectively.

Results

Descriptive statistics for all ADHD and bullying victimization and perpetration scores are provided in Table S1 of Supplementary Materials. The mean scores indicate that both the ADHD scores and the bullying scores generally fell towards the lower end of the scale, consistent with the fact that the sample is community-ascertained and not enriched for those at high risk of ADHD and/or bullying. Pearson correlations for the relations between teacher and self-reported ADHD scores and bullying victimization and perpetration are provided in Table S2 of Supplementary Materials. Correlations were generally as expected, with the largest correlations occurring within waves and across adjacent waves; high correlations between inattention and hyperactivity/impulsivity; low to moderate correlations between self- and teacher reports of ADHD; and moderate correlations between bullying victimization and perpetration.

Results from fitting the ALT-SR are provided in Tables 1-3 and visualised in Figures 1-6. Using ADHD symptom self-reports, findings were similar across the whole sample and gender-stratified analyses. In terms of developmental relations, ADHD symptoms predicted within-person increases in perpetration across both lags, but there were no significant effects of ADHD on victimization. The only substantive difference across the whole sample and gender-stratified analyses was an effect of ADHD symptoms at age 15 on bullying perpetration at age 17. This effect was positive and significant in the whole sample but when stratifying by gender was significant only in the male sample.

For teacher-reported inattention scores, findings were again mostly similar across the whole sample and gender-stratified analyses. In the perpetration model, there was a positive within-person effect of inattention on bullying perpetration across both lags (11 to 13 and 13 to 15); however, no relation in the opposite direction. In the victimization model, there was a positive within-person effect of age 11 victimization on age 13 inattention in the whole sample; however, this was significant for females only when stratifying analyses by gender. There was also a positive significant effect of age 11 inattention on age 13 victimization in the whole sample and gender-stratified analyses, suggesting that the relations between these constructs may be bidirectional in early adolescence.

For the models using teacher-reported hyperactivity/impulsivity scores, there was only weak evidence for a hyperactivity-perpetration link. Specifically, age 11 hyperactivity/impulsivity had a positive within-person effect on age 13 perpetration in the whole sample analyses but the statistical significance was marginal (p<.043) and the effect was significant in neither gender-specific analysis. Similarly, there was a significant within-person effect of hyperactivity/impulsivity at age 13 on perpetration at age 15; however, the effect was significant only in the female-specific analyses and with a p-value close to .05 (p=.037).

There were also some differences in the results pertaining to the relations between bullying victimization and hyperactivity/impulsivity in the whole sample versus gender-stratified results, reflecting the fact that the effects were relatively weak. There was a negative within-person effect of victimization at age 13 on hyperactivity/impulsivity at age 15 but its significance was marginal and it was non-significant in both of the gender-specific samples. Similarly, there was a positive effect of victimization at age 11 on hyperactivity/impulsivity at age 13 but again the

significance was marginal in the whole sample and the effect was non-significant in both of the gender-specific samples. Arguably, the most statistically compelling bullying-hyperactivity/impulsivity relation in this model was a negative effect of hyperactivity at age 13 on victimization at age 15. This was significant in both the whole sample and the male sample but not the female sample.

Discussion

In this study we explored the developmental relations between ADHD symptoms and bullying victimization and perpetration. Using ALT-SRs (Curran et al., 2014), we found evidence for a within-person effect of ADHD symptoms on bullying perpetration, with ADHD symptoms predicting relative increases in perpetration in adolescence. Analyses of teacher-reported ADHD symptoms suggested that the effect of ADHD symptoms on perpetration was driven by inattention rather than hyperactivity/impulsivity. There was also some evidence for possible bidirectional developmental relations involving victimization and ADHD symptoms but these were limited to the teacher-reports. Similarly, there was some evidence that bullying perpetration also impacts on ADHD symptoms; however, this was only observed in the self-reports. These latter, less consistent effects may be worthy of further exploration in future studies.

Our results were consistent with the hypothesis that ADHD symptoms predict within-person increases in bullying perpetration. Though some previous studies have identified an association between ADHD symptoms and bullying perpetration (e.g., Verlinden et al., 2015), evidence has been mixed overall and much of it has been based on cross-sectional samples that cannot inform on the direction of effects (e.g., Bacchini et al., 2008; Fite et al., 2014; Sciberras et al., 2012) . Finding a directional effect of ADHD symptoms on perpetration in a high-quality longitudinal sample using a rigorous

statistical technique that helps partial out between-person confounds (see e.g., Berry & Willoughby, 2017) thus contributes some of the strongest evidence yet in favor of the idea that ADHD symptoms influence bullying perpetration behavior. The fact that this effect was replicated across both self-reports and teacher-reports of bullying and across multiple time lags adds further weight to this evidence.

It is possible that the effect of ADHD symptoms on bullying perpetration can be explained by the socio-emotional difficulties associated with ADHD that can increase the risk of peer rejection, affiliating with deviant peers, and aggressive behavior (Staikova, Gomes, Tartter, McCabe, & Halperin, 2013; Villemonteix, Purper-Ouakil, & Romo, 2015; Wehmeier et al., 2010). This would also suggest that the perpetration profiles of individuals with ADHD symptoms may not fit that of the prototypical perpetrator of bullying who uses bullying instrumentally to gain social status (Salmivalli, 2010). Rather, the perpetration behavior of individuals with ADHD may more closely resemble impulsive or reactive aggression, driven by emotional and behavioral regulation difficulties and impaired social skills (e.g., A. L. Murray, Obsuth, Zirk-Sadowski, et al., 2016). It is, however, also possible that individuals with elevated ADHD symptoms utilize bullying to gain and maintain social status to a greater extent than their normative peers because of difficulties in drawing on more adaptive strategies for developing and maintaining peer relationships (Wehmeier et al., 2010). Identifying the mechanisms mediating this relation has implications for bullying interventions which, in the context of ADHD, should address not only bullying attitudes and norms, but promote strategies to enhance factors such as behavioral regulation and social skills depending on which factors are most important in mediating the association.

ADHD symptoms did not, however, strongly predict bullying victimization. The only relevant effect was a negative effect of teacher-reported hyperactivity on

victimization across ages 13 and 15. It has previously been suggested that elevated ADHD symptoms may result in adolescents being both easy and appealing targets because of the tendencies for ADHD symptoms to be associated with low peer status and a liability to responding aggressively to provocation (Roy et al., 2015). The lack of positive association in the current study may reflect an understanding among adolescents that it is not acceptable to victimize individuals with special or additional educational needs. This finding suggests that in relation to ADHD, targeting perpetration behaviors is a higher priority than addressing potential victimization risk.

From the perspective of reducing bullying, our results suggest that it would be important to ensure that interventions address the possible role of ADHD-like features in perpetration. That is, they should acknowledge that some bullying behavior may be impulsive, reactive, and a function of impaired behavioral regulation and social skills, rather than instrumental. Previous meta-analyses have suggested that behavioral regulation can be improved through programmatic interventions (Piquero, Jennings, Farrington, Diamond, & Gonzalez, 2016), and the effective components of these interventions could be more fully incorporated into anti-bullying interventions. Similarly, it is important to ensure that interventions are delivered in such a way that individuals with ADHD symptoms are able to benefit from them. Many bullying interventions are heavily curriculum and classroom-based (e.g., Gaffney et al., 2019) and individuals with elevated levels of ADHD symptoms may struggle to maintain concentration for their duration. More dynamic and interactive delivery (e.g., gamification of learning components) may help better engage individuals with ADHD symptoms.

Limitations and Future Directions

It is important to note the limitations of the current study. First, our measures of bullying were limited to self-reports. Ideally future studies should use a multi-informant approach and seek information from not only self- but peer, teacher, and parent reports. Second, we had only brief measures of ADHD and bullying, therefore, we could not disentangle which aspects of ADHD are most important for which types of bullying. Third, we used a two-step approach in our analysis rather than a fully latent specification. The most likely impact of this is that the cross-lagged effects were somewhat attenuated due to unreliability. Fourth, we focused on ADHD-bullying relations in adolescence, thus our findings do not necessarily generalise to over developmental periods. Despite the fact that ADHD symptoms persist into adulthood for approximately 15-65% of childhood cases (Caye et al., 2016) there has been almost no research into ADHD-bullying relations beyond adolescence. This will thus be an important gap to address in future studies. Finally, our sample was community-ascertained. Our sample is thus ideal for drawing inferences regarding bullying and ADHD symptoms for adolescents attending mainstream schools; the setting for the vast majority of bullying interventions. However, most adolescents in mainstream schools such as those sampled in the current study, will not meet diagnostic criteria for ADHD. Future studies designed to illuminate ADHD-bullying relations specifically in clinically diagnosed and/or other high-risk populations would, therefore, be beneficial. Unfortunately, it was not possible to tell which participants met clinical diagnostic criteria for ADHD in the current study.

Conclusion

ADHD symptoms increase the risk of bullying perpetration. Results point to a need to ensure that bullying interventions are delivered in such a way that individuals

with ADHD can benefit and are addressing bullying perpetration antecedents that are related to ADHD, such as difficulties regulating emotions and behavior.

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Table 1:

ALT-SR standardised autoregressive and cross-lagged parameters for self-reported ADHD symptoms

Parameter	Overall sample			Males			Females		
	Estimate	SE	*p*	Estimate	SE	*p*	Estimate	SE	*p*
Perpetration Model									
ADHD age 17 on ADHD age 15	.42	.07	<.001	.43	.09	<.001	.40	.11	<.001
ADHD age 17 on Perpetration age 15	.13	.04	.001	.14	.05	.007	.13	.11	.047
Perpetration age 17 on ADHD age 15	.13	.06	.026	.20	.08	.009	.02	.09	.845
Perpetration age 17 on Perpetration age 15	.37	.05	<.001	.34	.06	<.001	.42	.06	<.001
ADHD age 15 on ADHD age 13	.41	.07	<.001	.46	.09	<.001	.36	.10	<.001
ADHD age 15 on Perpetration age 13	.06	.05	.231	.05	.07	.524	.08	.08	.319
Perpetration age 15 on ADHD age 13	.19	.05	<.001	.21	.07	.001	.14	.07	.046
Perpetration age 15 on Perpetration age 13	.28	.05	<.001	.27	.06	<.001	.29	.06	<.001
Victimization Model									

ADHD age 17 on ADHD age 15	.39	.07	<.001	.42	.09	<.001	.37	.12	.002
ADHD age 17 on Victimization age 15	.07	.05	.160	.12	.07	.060	.01	.08	.946
Victimization age 17 on ADHD age 15	-.08	.06	.183	.00	.07	.97	-.17	.10	.094
Victimization age 17 on Victimization age 15	.44	.06	<.001	.48	.07	<.001	.37	.11	.001
ADHD age 15 on ADHD age 13	.39	.06	<.001	.44	.08	<.001	.35	.09	<.001
ADHD age 15 on Victimization age 13	.03	.06	.577	.04	.07	.581	.02	.10	.844
Victimization age 15 on ADHD age 13	.02	.05	.701	.09	.06	.164	-.06	.07	.429
Victimization age 15 on Victimization age 13	.45	.05	<.001	.48	.06	<.001	.40	.09	<.001

Table 2:

ALT-SR standardised autoregressive and cross-lagged parameters for teacher-reported inattention

Parameter	Overall sample			Males			Females		
	Estimate	SE	*p*	Estimate	SE	*p*	Estimate	SE	*P*
Perpetration Model									
Inattention age 15 on Inattention age 13	.29	.06	<.001	.21	.09	.017	.30	.07	<.001
Inattention age 15 on Perpetration age 13	.07	.04	.095	.05	.06	.417	.07	.05	.215
Perpetration age 15 on Inattention age 13	.29	.04	<.001	.24	.06	<.001	.28	.06	<.001
Perpetration age 15 on Perpetration age 13	.21	.04	<.001	.19	.06	.001	.24	.06	<.001
Inattention age 13 on Inattention age 11	.17	.06	.004	.19	.08	.021	.06	.09	.479
Inattention age 13 on Perpetration age 11	.13	.07	.070	.07	.10	.509	.16	.08	.054
Perpetration age 13 on Inattention age 11	.24	.06	<.001	.22	.09	.013	.21	.08	.009
Perpetration age 13 on Perpetration age 11	-.09	.10	.401	-.11	.14	.419	-.01	.12	.949
Victimization Model									
Inattention age 15 on Inattention age 13	.31	.05	<.001	.22	.09	.013	.32	.07	<.001

Inattention age 15 on Victimization age 13	.02	.05	.668	.02	.08	.853	.05	.05	.363
Victimization age 15 on Inattention age 13	.01	.04	.766	-.00	.06	.946	.03	.04	.518
Victimization age 15 on Victimization age 13	.52	.05	<.001	.44	.08	<.001	.61	.06	<.001
Inattention age 13 on Inattention age 11	.17	.06	.007	.19	.08	.024	.07	.10	.473
Inattention age 13 on Victimization age 11	.16	.05	.002	.14	.07	.062	.20	.08	.015
Victimization age 13 on Inattention age 11	.18	.06	.007	.18	.08	.029	.18	.07	.010
Victimization age 13 on Victimization age 11	.34	.06	<.001	.26	.09	.003	.43	.09	<.001

Table 3:

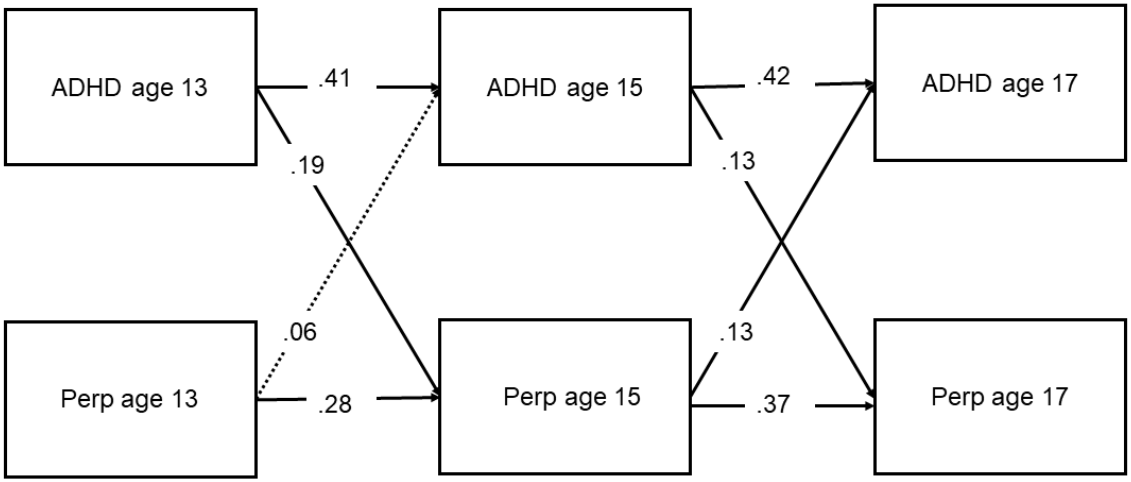
ALT-SR standardised autoregressive and cross-lagged parameters for teacher-reported hyperactivity/impulsivity

Parameter	Overall sample			Males			Females		
	Estimate	SE	*P*	Estimate	SE	*p*	Estimate	SE	*p*
Perpetration Model									
Hyperactivity age 15 on Hyperactivity age 13	.40	.06	<.001	.43	.08	<.001	.42	.10	<.001
Hyperactivity age 15 on Perpetration age 13	.00	.43	.991	-.03	.04	.373	.03	.04	.457
Perpetration age 15 on Hyperactivity age 13	.08	.05	.075	.03	.10	.767	.22	.11	.037
Perpetration age 15 on Perpetration age 13	.28	.04	<.001	.28	.07	<.001	.37	.06	<.001
Hyperactivity age 13 on Hyperactivity age 11	.24	.08	.003	.19	.10	.061	.19	.13	.158
Hyperactivity age 13 on Perpetration age 11	.01	.08	.947	-.00	.13	.987	.01	.10	.945
Perpetration age 13 on Hyperactivity age 11	.14	.07	.045	.15	.12	.215	.13	.12	.290
Perpetration age 13 on Perpetration age 11	-.07	.10	.529	-.10	.21	.619	-.01	.20	.971
Victimization model									
Hyperactivity age 15 on Hyperactivity age 13	.39	.06	<.001	.39	.07	<.001	.42	.09	<.001

Hyperactivity age 15 on Victimization age 13	-.10	.05	.038	-.12	.07	.072	-.03	.04	.452
Victimization age 15 on Hyperactivity age 13	-.13	.04	<.001	-.19	.05	<.001	-.06	.07	.394
Victimization age 15 on Victimization age 13	.51	.05	<.001	.41	.08	<.001	.59	.06	<.001
Hyperactivity age 13 on Hyperactivity age 11	.18	.08	.019	.12	.10	.236	.15	.13	.245
Hyperactivity age 13 on Victimization age 11	.13	.06	.039	.16	.09	.077	.07	.06	.270
Victimization age 13 on Hyperactivity age 11	-.02	.06	.679	.02	.09	.801	-.10	.10	.345
Victimization age 13 on Victimization age 11	.36	.06	<.001	.26	.09	.004	.54	.09	<.001

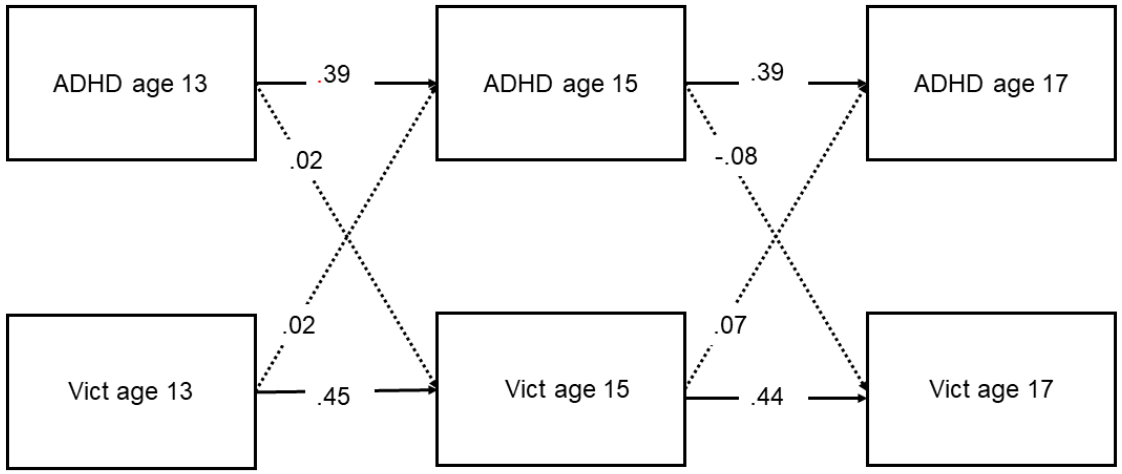
Figures

Figure 1: Autoregressive and cross-lagged parameters from ALT-SR examining self-reported ADHD and perpetration relations



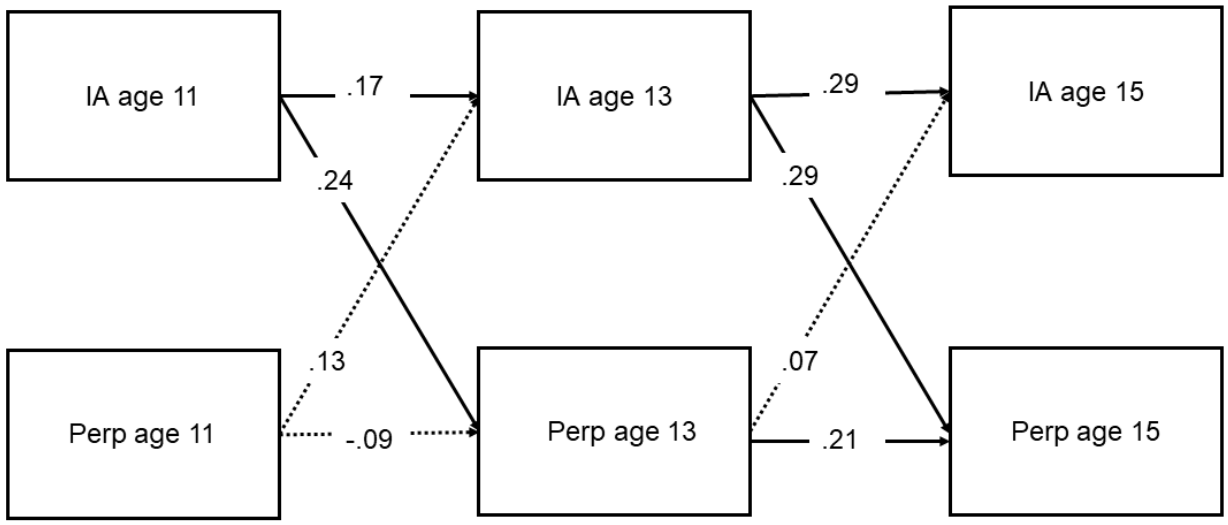
Note. Perp= bullying perpetration. Solid lines represent statistically significant paths while dotted lines represent non-significant paths at $p<.05$.

Figure 2: Autoregressive and cross-lagged parameters from ALT-SR examining self-reported ADHD and victimization relations



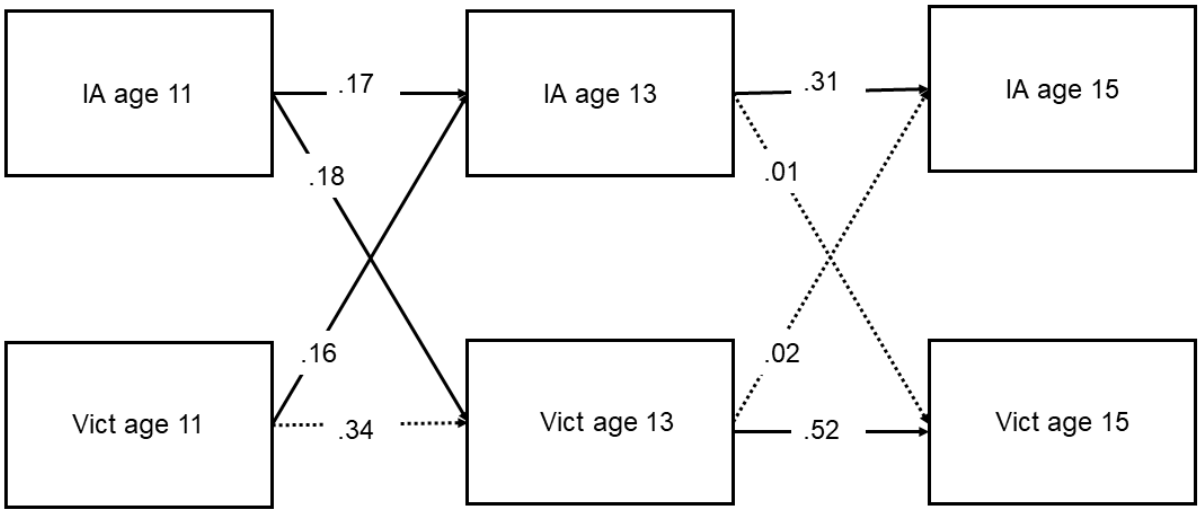
Note. Vict= bullying victimization. Solid lines represent statistically significant paths while dotted lines represent non-significant paths at $p<.05$.

Figure 3: Autoregressive and cross-lagged parameters from ALT-SR examining teacher-reported inattention and perpetration relations



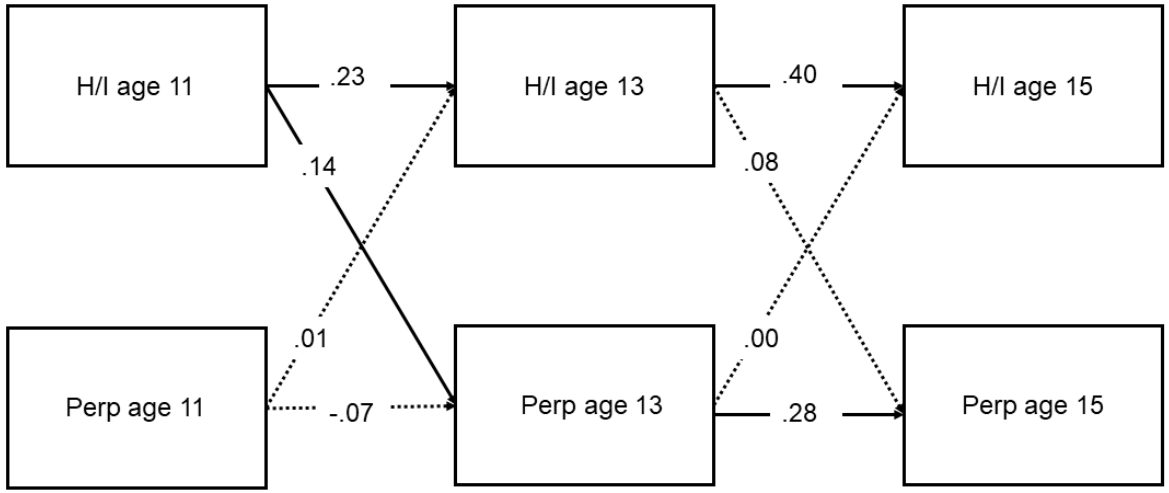
Note. IA=inattention; Perp= bullying perpetration. Solid lines represent statistically significant paths while dotted lines represent non-significant paths at $p<.05$.

Figure 4: Autoregressive and cross-lagged parameters from ALT-SR examining teacher-reported inattention and victimization relations



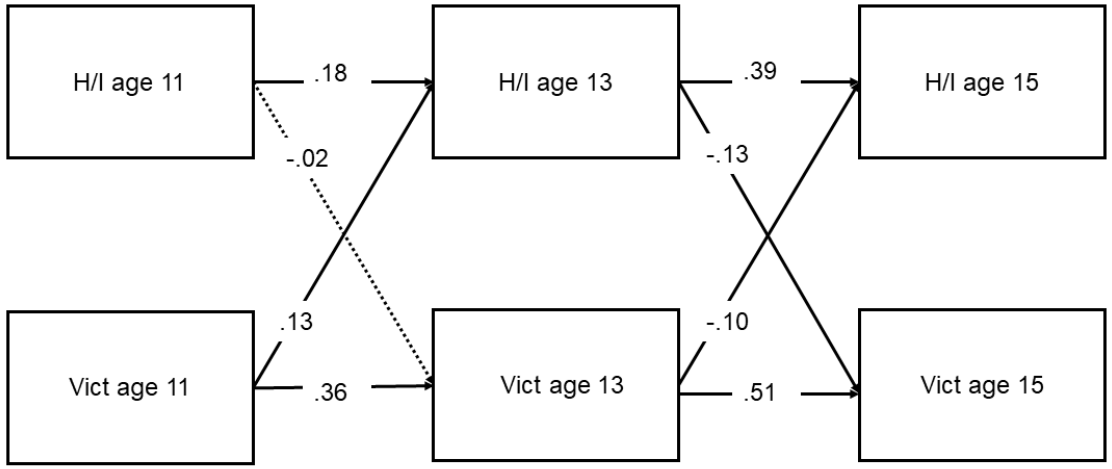
Note. IA=inattention; Vict= bullying victimization. Solid lines represent statistically significant paths while dotted lines represent non-significant paths at $p<.05$.

Figure 5: Autoregressive and cross-lagged parameters from ALT-SR examining teacher-reported hyperactivity/impulsivity and perpetration relations



Note. H/I=hyperactivity/impulsivity; Perp= bullying perpetration. Solid lines represent statistically significant paths while dotted lines represent non-significant paths at $p<.05$.

Figure 6: Autoregressive and cross-lagged parameters from ALT-SR examining teacher-reported hyperactivity/impulsivity and victimization relations



H/I=hyperactivity/impulsivity; Vict= bullying victimisation. Solid lines represent statistically significant paths while dotted lines represent non-significant paths at $p<.05$.